

RF TEST REPORT

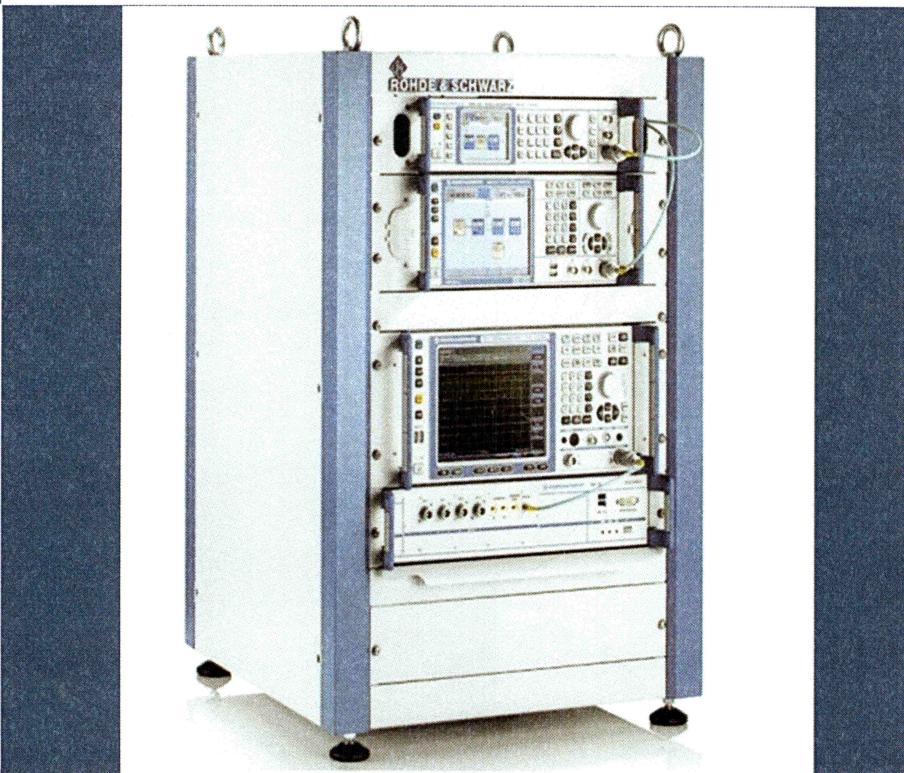
ISSUED BY
Shenzhen BALUN Technology Co., Ltd.



FOR
Hub M2

ISSUED TO
Konec Home Pty Ltd

Suite 5.02 level 5 15 Talavera Road Macquarie Park NSW 2113
Australia



Tested by: Ye Hongji

Date: Aug. 12, 2021

Approved by: Wei Yanquan
(Chief Engineer)

Date: Aug. 12, 2021

Report No.: BL-SZ2140980-601
EUT Name: Hub M2
Model Name: HM2-G01
Brand Name: Aqara
Test Standard: AS/NZS 4268:2017 (refer section 3)

Test Conclusion: Pass
Test Date: Apr. 28, 2021 ~ May 17, 2021
Date of Issue: Aug. 12, 2021

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Revision History

Version	Issue Date	Revisions Content
<u>Rev. 01</u>	<u>Aug. 12, 2021</u>	<u>Initial Issue</u>

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1 ADMINISTRATIVE DATA (GENERAL INFORMATION)

1.1 Identification of the Testing Laboratory

Company Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Phone Number	+86 755 6685 0100

1.2 Identification of the Responsible Testing Location

Test Location	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Description	All measurement facilities used to collect the measurement data are located at Block B, FL 1, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China 518055

1.3 Laboratory Condition

Ambient Temperature	20°C to 25°C
Ambient Relative Humidity	45% to 55%
Ambient Pressure	100 kPa to 102 kPa

1.4 Announce

- (1) The test report reference to the report template version v1.2.
- (2) The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.
- (3) The test report is invalid if there is any evidence and/or falsification.
- (4) The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein.
- (5) This document may not be altered or revised in any way unless done so by BALUN and all revisions are duly noted in the revisions section.
- (6) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	Konec Home Pty Ltd
Address	Suite 5.02 level 5 15 Talavera Road Macquarie Park NSW 2113 Australia

2.2 Manufacturer Information

Manufacturer	Lumi United Technology Co., Ltd
Address	8th Floor, JinQi Wisdom Valley, No.1 Tangling Road, Liuxian Ave, Taoyuan Residential District, Nanshan District, Shenzhen, China

2.3 Factory Information

Factory	N/A
Address	N/A

2.4 General Description for Equipment under Test (EUT)

EUT Name	Hub M2
Under Test Model Name	HM2-G01
Series Model Name	N/A
Description of Model name differentiation	N/A
Hardware Version	V1.1.0
Software Version	3.0.6_0005.0515
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

2.5 Technical Information

EUT Type	Stand-alone equipment
Network and Wireless connectivity	Zigbee, Bluetooth BLE, Wi-Fi 802.11b, 802.11g, 802.11n(HT20/40)

The requirement for the following technical information of the EUT was tested in this report:

Modulation Technology	Bluetooth Low Energy: Wide band modulations other than FHSS
Modulation Type	Bluetooth Low Energy: GFSK
Transfer Rate	BLE: 1 Mbps
Frequency Range	The frequency range used is 2402 MHz – 2480 MHz; The frequency block is 2400 MHz to 2483.5 MHz.
Number of channel	Bluetooth Low Energy: 40 (at intervals of 2 MHz)
Tested Channel	Bluetooth Low Energy: 0 (2402 MHz), 19 (2440 MHz), 39 (2480 MHz)
Nominal Channel Bandwidth	1 MHz
Antenna Type	PCB Antenna
Antenna Gain	0 dBi (In test items related to antenna gain, the final results reflect this figure.)
Beamforming Gain	N/A
Adaptive or non-adaptive	Adaptive
LBT Based	Yes (Load Based)
The Max RF Output power	Bluetooth Low Energy: 6.5 dBm
Receiver Category	Bluetooth Low Energy: 2

2.6 Additional Instructions

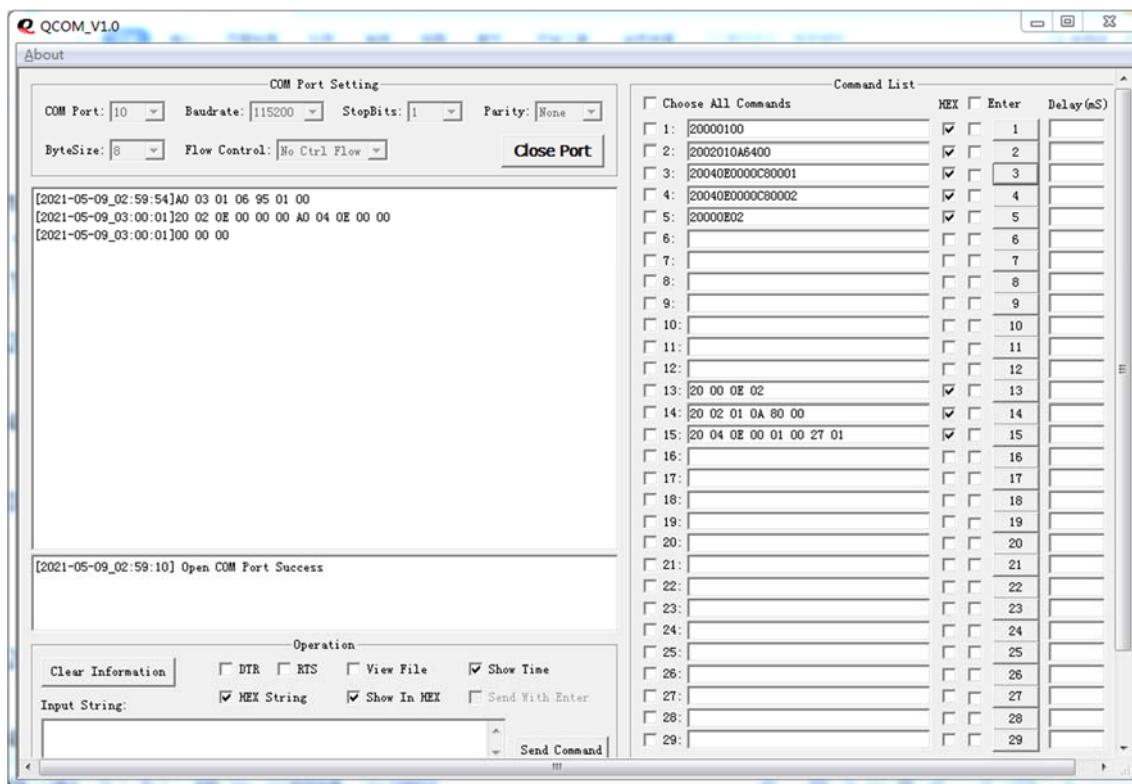
Bluetooth Low Energy

EUT Software Settings:

Mode	<input checked="" type="checkbox"/> Special software is used. The software provided by client to enable the EUT under transmission condition continuously at specific channel frequencies individually.
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Power level setup in software			
Test Software Version	QCOM_V1.0		
Support Units (Software installation media)	Description	Manufacturer	Model
	Notebook	Dell	X220
Mode	Channel	Frequency (MHz)	Soft Set
GFSK	CH0	2402	TX LEVEL is built-in set parameters and cannot be changed and selected.
	CH19	2440	
	CH39	2480	

Run Software



3 SUMMARY OF TEST RESULTS

No.	Identity	Document Title
1	AS/NZS 4268:2017	Radio equipment and systems - Short range devices - Limits and methods of measurement
2	ETSI EN 300 328 V2.2.2 (2019-07)	Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU

Test items and the results are as follows:

Report Section	Standard Rule	Description	Channel (BLE)	Test Result	Verdict	Remark
Transmitter Parameters						
5.1.1	4.3.1.2 4.3.2.2	RF output power	Low/Middle/High	ANNEX A.1	Pass	--
5.1.2	4.3.2.3	Power Spectral Density	Low/Middle/High	ANNEX A.2	Pass	Note ⁴
5.1.3	4.3.1.3 4.3.2.4	Duty Cycle, Tx-sequence, Tx-gap	N/A	ANNEX A.3	N/A	Note ² , Note ⁷
5.1.4	4.3.1.4	Accumulated Transmit Time, Frequency Occupation and Hopping Sequence	--	ANNEX A.4	N/A	Note ⁵
5.1.5	4.3.1.5	Hopping Frequency Separation	--	ANNEX A.5	N/A	Note ⁵
5.1.6	4.3.1.6 4.3.2.5	Medium Utilisation (MU) factor	N/A	ANNEX A.6	N/A	Note ² , Note ⁷
5.1.7	4.3.1.7 4.3.2.6	Adaptivity	N/A	ANNEX A.7	N/A	Note ² , Note ³
5.1.8	4.3.1.8 4.3.2.7	Occupied Channel Bandwidth	Low/ High	ANNEX A.8	Pass	--
5.1.9	4.3.1.9 4.3.2.8	Transmitter unwanted emissions in the out-of-band domain	Low/High	ANNEX A.9	Pass	--
5.1.10	4.3.1.10 4.3.2.7	Transmitter unwanted emissions in the spurious domain	Low/High	ANNEX A.10	Pass	--
Receiver Parameters						
5.2.1	4.2.3.2	Receiver categories	--	--	--	--
5.2.2	4.3.1.11 4.3.2.10	Receiver spurious emissions	Low/High	ANNEX A.11	Pass	--
5.2.3	4.3.1.12 4.3.2.11	Receiver Blocking	Low/High	ANNEX A.12	Pass	--
Other Parameters						
5.3.1	4.3.1.13 4.3.2.12	Geo-location capability	--	--	--	Note ⁶

Note ¹: This requirement does not apply to adaptive equipment unless operating in a non-adaptive mode.

Note ²: This test doesn't apply for the EUT which has the RF Output power is less than 10 dBm e.i.r.p.

Note ³: This requirement does not apply to non-adaptive equipment or adaptive equipment operating in a non-adaptive mode.

Note ⁴: This requirement apply to the equipment is using wide band modulations other than FHSS.

Note ⁵: This requirement apply to the equipment is using FHSS.

Note ⁶: The function of Geo-location capability is declared by manufacture, for a more detailed description, please refer to the user manual.

Note ⁷: This requirements apply to non-adaptive frequency hopping equipment or to adaptive frequency hopping equipment operating in a non-adaptive mode.

Description	Modulation Type (BLE)	Transfer Rate(BLE)
Transmitter Parameters		
RF output power	GFSK	1 Mbps
Power Spectral Density	GFSK	1 Mbps
Duty Cycle, Tx-sequence, Tx-gap	N/A	N/A
Accumulated Transmit Time, Frequency Occupation and Hopping Sequence	--	--
Hopping Frequency Separation	--	--
Medium Utilisation (MU) factor	N/A	N/A
Adaptivity	N/A	N/A
Occupied Channel Bandwidth	GFSK	1 Mbps
Transmitter unwanted emissions in the out-of-band domain	GFSK	1 Mbps
Transmitter unwanted emissions in the spurious domain	GFSK	1 Mbps
Receiver Parameters		
Receiver spurious emissions	GFSK	1 Mbps
Receiver Blocking	GFSK	1 Mbps
Other Parameters		
Geo-location capability	--	--

4 GENERAL TEST CONFIGURATIONS

4.1 Test Environments

During the measurement, the normal environmental conditions were within the listed ranges:

Relative Humidity	45% - 55%		
Atmospheric Pressure	100 kPa - 102 kPa		
Temperature	NT (Normal Temperature)	+22°C to +25°C	
	LT (Low Temperature)	-10°C	
	HT (High Temperature)	+40°C	
Working Voltage of the EUT	NV (Normal Voltage)	3.7 V	

4.2 Test Equipment List

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer	ROHDE&SCHWARZ	FSV-30	103118	2020.06.08	2021.06.07
Spectrum Analyzer	KEYSIGHT	N9020A	MY56060183	2020.09.25	2021.09.24
Vector Signal Generator	ROHDE&SCHWARZ	SMBV100A	260592	2020.06.08	2021.06.07
Signal Generator	ROHDE&SCHWARZ	SMB100A	177746	2020.06.08	2021.06.07
Switch Unit with OSP-B157	ROHDE&SCHWARZ	OSP120	101270	2020.06.08	2021.06.07
Bluetooth Signaling Unit	ROHDE&SCHWARZ	CMW270	100607	2020.06.08	2021.06.07
Bluetooth Signaling Unit	ROHDE&SCHWARZ	CMW500	142028	2020.06.08	2021.06.07
Bluetooh Signaling Unit	ROHDE&SCHWARZ	CBT	101005	2020.06.08	2021.06.07
EMI Receiver	KEYSIGHT	N9038A	MY53220118	2020.06.09	2021.06.08
Test Antenna-Loop(9 kHz-30 MHz)	SCHWARZBECK	FMZB 1519	1519-037	2019.10.29	2021.10.28
Test Antenna-Bi-Log(30 MHz-3 GHz)	SCHWARZBECK	VULB 9163	9163-624	2019.07.02	2021.07.01
Test Antenna-Horn(1-18 GHz)	SCHWARZBECK	BBHA 9120D	9120D-1917	2019.07.02	2021.07.01
Test Antenna-Horn (18-40 GHz)	A-INFO	LB-180400KF	J211060273	2021.01.05	2023.01.04
Anechoic Chamber	RAINFORD	9m*6m*6m	N/A	2017.02.21	2022.02.20

4.3 Test Software List

Description	Manufacturer	Software Version	Serial No.
TS8997 EMC32	ROHDE&SCHWARZ	V10.00.00	N/A

4.4 Measurement Uncertainty

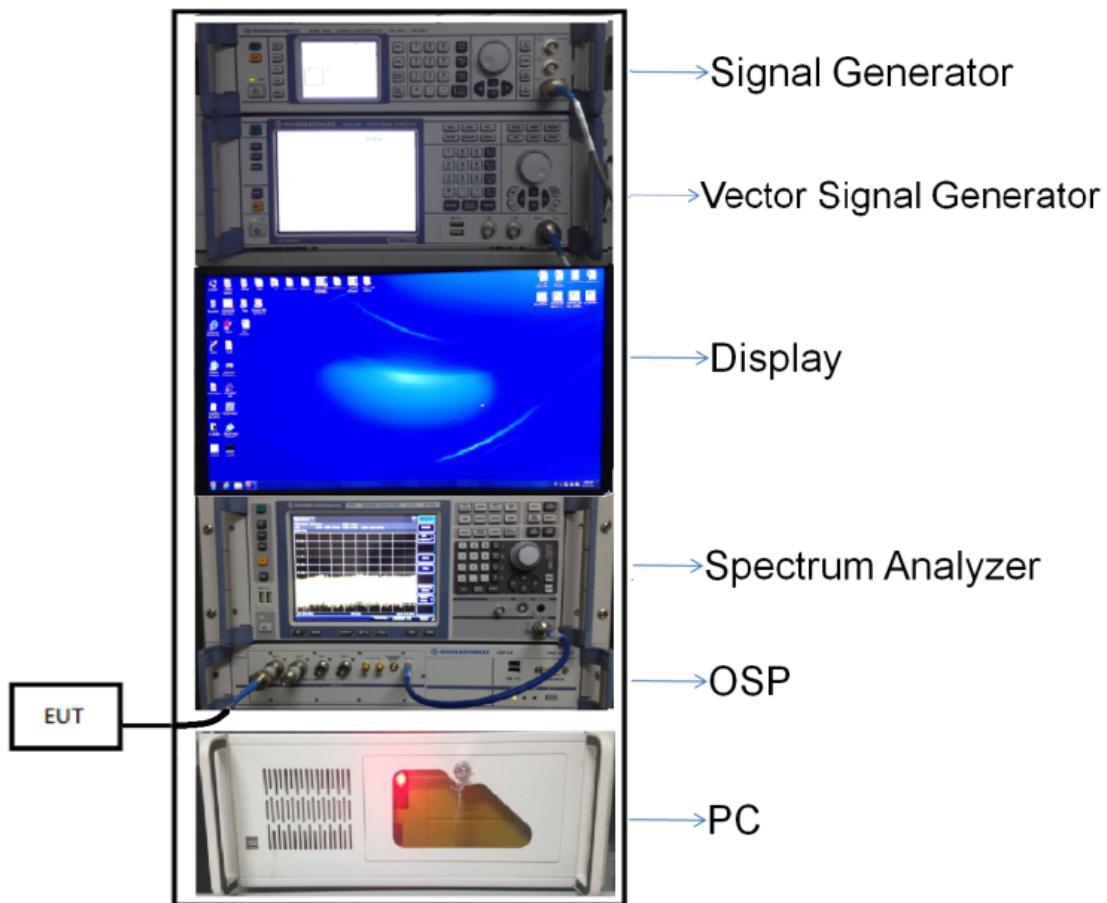
The following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2.

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Measurement	Value
Occupied Channel Bandwidth	±4 %
RF output power, conducted	±1.21 dB
Power Spectral Density, conducted	±1.25 dB
Unwanted Emissions, conducted	±1.26 dB
All emissions, radiated	±3.86 dB
Temperature	±1 °C
Humidity	±4 %

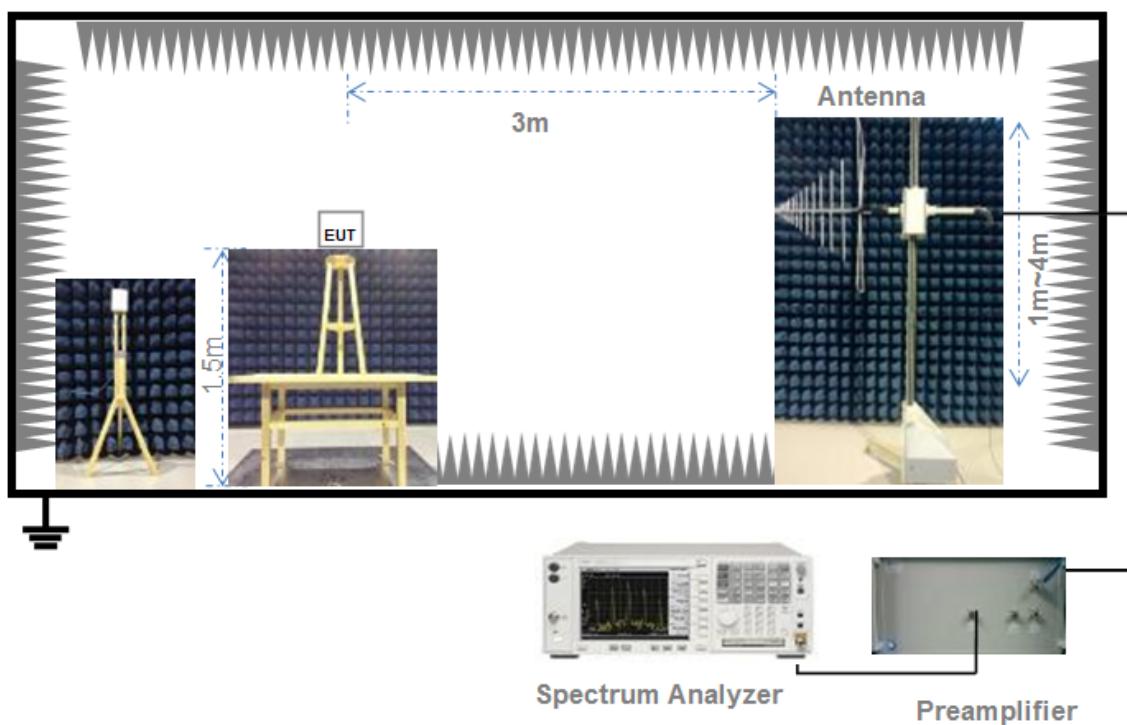
4.5 Description of Test Setup

4.5.1 For Conducted Test

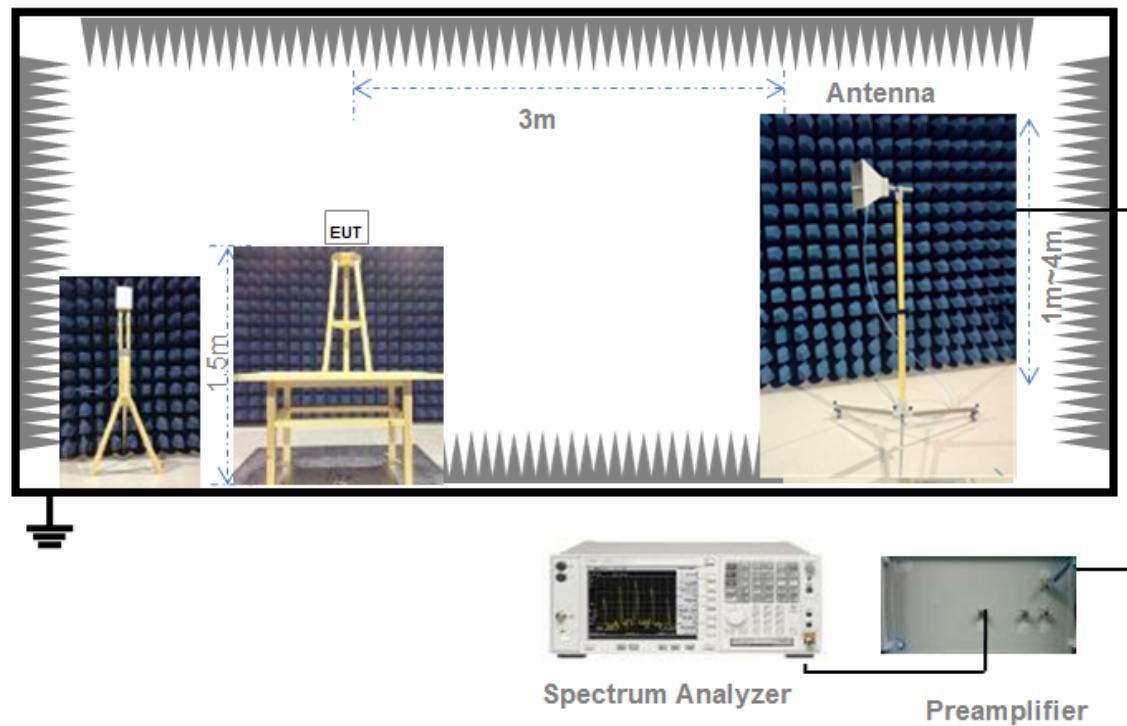


(Diagram 1)

4.5.2 For Radiated Test

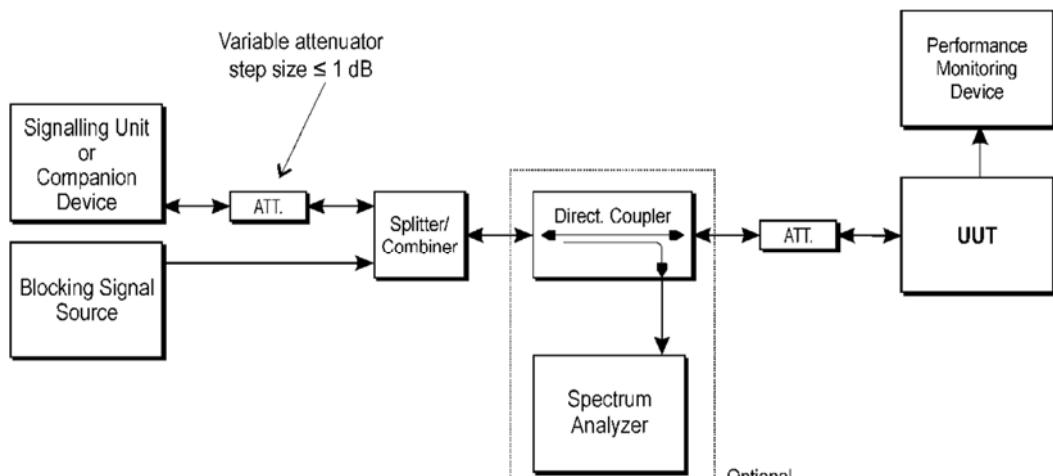


(Diagram 2)



(Diagram 3)

4.5.3 For Receiver Blocking Test



(Diagram 4)

5 Test Type and Test Results

5.1 Transmitter Parameters

5.1.1 RF output power

5.1.1.1 Limit

The maximum RF output power shall be equal to or less than 20 dBm.

5.1.1.2 Test Setup

The section 4.5.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.1.1.3 Test Procedure

Reference to ETSI EN 300 328 V2.1.1 clause 5.4.2.2.

5.1.1.4 Test Result

Please refer to ANNEX A.1.

5.1.2 Power Spectral Density

5.1.2.1 Limit

For equipment using wide band modulations other than FHSS, the maximum Power Spectral Density is limited to 10 dBm per MHz.

5.1.2.2 Test Setup

The section 4.5.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.1.2.3 Test Procedure

Reference to ETSI EN 300 328 V2.1.1 clause 5.4.3.2.

5.1.2.4 Test Result

Please refer to ANNEX A.2.

5.1.3 Duty Cycle, Tx-sequence, Tx-gap

5.1.3.1 Limit

For non-adaptive FHSS equipment, the Duty Cycle shall be equal to or less than the maximum value declared by the supplier. In addition, the maximum Tx-sequence time shall be 5 ms while the minimum Tx-gap time shall be 5 ms.

For equipment using wide band modulations other than FHSS, the Duty Cycle shall be equal to or less than the maximum value declared by the supplier. In addition, The Tx-sequence time shall be equal to or less than 10 ms. The minimum Tx-gap time following a Tx-sequence shall be equal to the duration of that proceeding Tx-sequence with a minimum of 3,5 ms.

5.1.3.2 Test Setup

The section 4.5.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.1.3.3 Test Procedure

Reference to ETSI EN 300 328 V2.1.1 clause 5.4.2.2.

5.1.3.4 Test Result

Please refer to ANNEX A.3.

5.1.4 Accumulated Transmit Time, Frequency Occupation and Hopping Sequence

5.1.4.1 Limit

The Accumulated Transmit Time on any hopping frequency shall not be greater than 15 ms within any observation period of 15 ms multiplied by the minimum number of hopping frequencies (N) that have to be used.

The hopping sequence(s) shall contain at least N hopping frequencies where N is 15 or 15 divided by the minimum Hopping Frequency Separation in MHz, whichever is the greater.

In order for the equipment to comply with the Frequency Occupation requirement, it shall meet either of the following two options:

Option 1: Each hopping frequency of the hopping sequence shall be occupied at least once within a period not exceeding four times the product of the dwell time and the number of hopping frequencies in use.

Option 2: The occupation probability for each frequency shall be between $((1 / U) \times 25\%)$ and 77 % where U is the number of hopping frequencies in use.

5.1.4.2 Test Setup

The section 4.5.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.1.4.3 Test Procedure

Reference to ETSI EN 300 328 V2.1.1 clause 5.4.4.2.

5.1.4.4 Test Result

Please refer to ANNEX A.4.

5.1.5 Hopping Frequency Separation

5.1.5.1 Limit

For adaptive frequency hopping systems, the minimum Hopping Frequency Separation shall be 100 kHz.

5.1.5.2 Test Setup

The section 4.5.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.1.5.3 Test Procedure

Reference to ETSI EN 300 328 V2.1.1 clause 5.4.5.2.

5.1.5.4 Test Result

Please refer to ANNEX A.5.

5.1.6 Medium Utilisation (MU) factor

5.1.6.1 Limit

For non-adaptive equipment, the maximum Medium Utilisation factor shall be 10 %.

5.1.6.2 Test Setup

The section 4.5.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.1.6.3 Test Procedure

Reference to ETSI EN 300 328 V2.1.1 clause 5.4.2.2.

5.1.6.4 Test Result

Please refer to ANNEX A.6.

5.1.7 Adaptivity

5.1.7.1 Limit

Adaptive Frequency Hopping

Requirement	Operational Mode	
	Non-LBT based Detect and Avoid	LBT based Detect and Avoid
Minimum Clear Channel Assessment (CCA) Time	NA	18 us (see Note ¹)
Maximum Channel Occupancy (COT) Time	40 ms	60 ms
Minimum Idle Period	5% of COT	5% of COT
Extended CCA check	NA	NA
Short Control Signalling Transmissions	Maximum duty cycle of 10 % within an observation period of 50 ms (see Note ²)	

Note ¹: The CCA time used by the equipment shall be declared by the supplier.

Note ²: Adaptive equipment may or may not have Short Control Signaling Transmissions.

Interference threshold level:

Maximum transmit power (P_H) EIRP dBm	Threshold level (TL) (see notes 1 and 2)
20	-70 dBm / MHz
Note ¹ : $TL = -70 \text{ dBm/MHz} + 10 \times \log_{10} (100 \text{ mW} / P_{\text{out}})$ (Pout in mW e.i.r.p.).	
Note ² : transmitter the CCA threshold level (TL) shall be equal or lower than -70 dBm/MHz at the input to the receiver (assuming a 0 dBi receive antenna).	

Unwanted Signal parameters

Wanted signal mean power from companion device	Unwanted signal frequency (MHz)	Unwanted CW signal power (dBm)
sufficient to maintain the link (see Note ²)	2 395 or 2 488,5 (see Note ¹)	-35 (see Note ³)
Note ¹ : The highest frequency shall be used for testing operating channels within the range 2400 MHz to 2 442 MHz, while the lowest frequency shall be used for testing operating channels within the range 2 442 MHz to 2 483.5 MHz. See clause 5.4.6.1.		
Note ² : A typical value which can be used in most cases is -50 dBm/MHz.		
Note ³ : The level specified is the level in front of the UUT antenna. In case of conducted measurements, this level has to be corrected by the actual antenna assembly gain.		

Adaptive equipment using modulations other than FHSS

Requirement	Operational Mode			
	Non-LBT based Detect and Avoid	LBT based Detect and Avoid		
		Frame Based Equipment	Load Based Equipment (CCA using 'energy detect')	Load Based Equipment (CCA not using any of the mechanisms referenced as Note ²)
Minimum Clear Channel Assessment (CCA) Time	NA	18 us (see Note ¹)	(see Note ²)	18 us (see Note ¹)
Maximum Channel Occupancy (COT) Time	40 ms	1 ms to 10 ms	(see Note ²)	13 ms
Minimum Idle Period	5% of COT	5% of COT	(see Note ²)	NA
Extended CCA check	NA	NA	(see Note ²)	a random duration in the range between 18 μ s and at least 160 μ s
Short Control Signalling Transmissions	Maximum duty cycle of 10 % within an observation period of 50 ms (see Note ³)			

Note ¹: The CCA time used by the equipment shall be declared by the supplier.

Note ²: Load Based Equipment may implement an LBT based spectrum sharing mechanism based on the Clear Channel Assessment (CCA) mode using energy detect, as described in IEEE 802.11™-2012 [i.3] clause 9, clause 10, clause 16, clause 17, clause 19 and clause 20, or in IEEE 802.15.4™-2011 [i.4], clause 4, clause 5 and clause 8

Note ³: Adaptive equipment may or may not have Short Control Signaling Transmissions.

Interference threshold level:

Maximum transmit power (P_H) EIRP dBm	Threshold level (TL) (see notes 1 and 2)
20	-70 dBm / MHz
Note 1: $TL = -70 \text{ dBm/MHz} + 10 \times \log_{10} (100 \text{ mW} / P_{out})$ (Pout in mW e.i.r.p.).	
Note 2: transmitter the CCA threshold level (TL) shall be equal or lower than -70 dBm/MHz at the input to the receiver (assuming a 0 dBi receive antenna).	

Unwanted Signal parameters

Wanted signal mean power from companion device	Unwanted signal frequency (MHz)	Unwanted CW signal power (dBm)
sufficient to maintain the link (see note 2)	2 395 or 2 488,5 (see note 1)	-35 (see note 3)
Note ¹ : The highest frequency shall be used for testing operating channels within the range 2400 MHz to 2 442 MHz, while the lowest frequency shall be used for testing operating channels within the range 2 442 MHz to 2 483.5 MHz. See clause 5.4.6.1.		
Note ² : A typical value which can be used in most cases is -50 dBm/MHz.		
Note ³ : The level specified is the level in front of the UUT antenna. In case of conducted measurements, this level has to be corrected by the actual antenna assembly gain.		

5.1.7.2 Test Setup

The section 4.5.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.1.7.3 Test Procedure

Reference to ETSI EN 300 328 V2.1.1 clause 5.4.6.2.

5.1.7.4 Test Result

Please refer to ANNEX A.7.

5.1.8 Occupied Channel Bandwidth

5.1.8.1 Limit

The Occupied Channel Bandwidth for each hopping frequency shall fall completely within the band 2400 MHz to 2483.5 MHz.

5.1.8.2 Test Setup

The section 4.5.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.1.8.3 Test Procedure

Reference to ETSI EN 300 328 V2.1.1 clause 5.4.7.2.

5.1.8.4 Test Result

Please refer to ANNEX A.8.

5.1.9 Transmitter unwanted emissions in the out-of-band domain

5.1.9.1 Limit

The transmitter unwanted emissions in the out-of-band domain but outside the allocated band, shall not exceed the values provided by the mask in figure 1.

NOTE: Within the 2400 M Hz to 2483,5 MHz band, the Out-of-band emissions are fulfilled by compliance with the Occupied Channel Bandwidth requirement in clause 4.3.1.8.

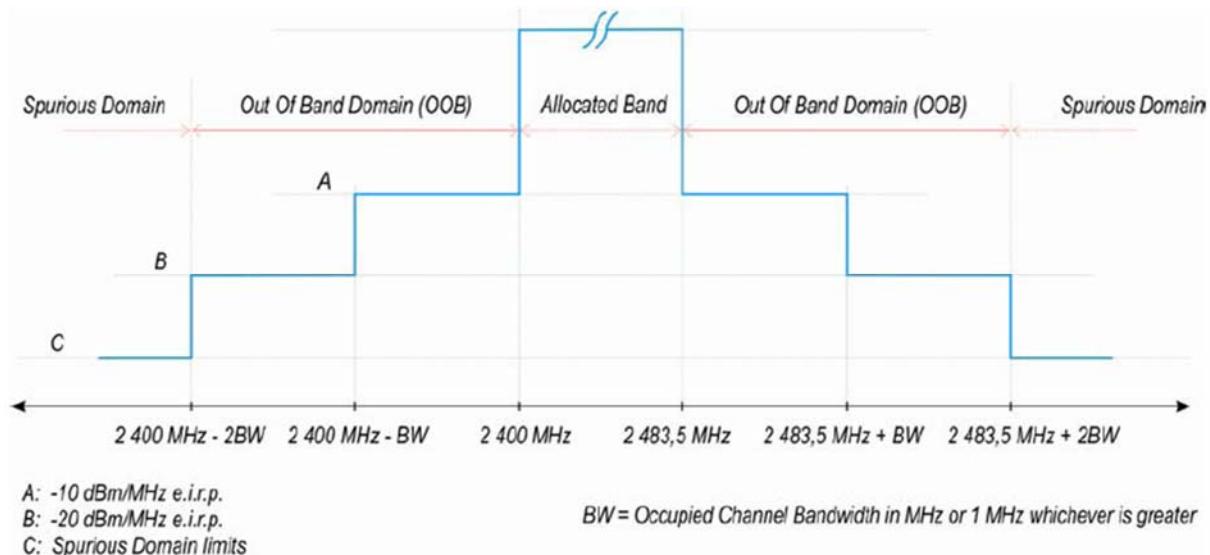


Figure 1: Transmit mask

5.1.9.2 Test Setup

The section 4.5.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.1.9.3 Test Procedure

Reference to ETSI EN 300 328 V2.1.1 clause 5.4.8.2.

5.1.9.4 Test Result

Please refer to ANNEX A.9.

5.1.10 Transmitter unwanted emissions in the spurious domain

5.1.10.1 Limit

The transmitter unwanted emissions in the spurious domain shall not exceed the values in following tables:

Frequency range	Maximum power (dBm)	Bandwidth
30 MHz to 47 MHz	-36	100 kHz
47 MHz to 74 MHz	-54	100 kHz
74 MHz to 87.5 MHz	-36	100 kHz
87.5 MHz to 118 MHz	-54	100 kHz
118 MHz to 174 MHz	-36	100 kHz
174 MHz to 230 MHz	-54	100 kHz
230 MHz to 470 MHz	-36	100 kHz
470 MHz to 862 MHz	-54	100 kHz
862 MHz to 1 GHz	-36	100 kHz
1 GHz to 12.75 GHz	-30	1 MHz

5.1.10.2 Test Setup

The section 4.5.1 and 4.5.2 (Diagram 1, 2, 3) for test setup description. The photo of test setup please refer to ANNEX B.

5.1.10.3 Test Procedure

Reference to ETSI EN 300 328 V2.1.1 clause 5.4.9.2.

5.1.10.4 Test Result

Please refer to ANNEX A.10.

5.2 Receiver Parameters

5.2.1 Receiver categories

There have three different receiver categories for which different receiver requirements and/or corresponding limits apply.

Receiver Category

Receiver Category	Definition
Category 1	Adaptive equipment with a maximum RF output power greater than 10 dBm e.i.r.p.
Category 2	Non-adaptive equipment with a Medium Utilization (MU) factor greater than 1 % and less than or equal to 10 % or adaptive equipment with a maximum RF output power of 10 dBm e.i.r.p.
Category 3	Non-adaptive equipment with a maximum Medium Utilization (MU) factor of 1 % or adaptive equipment with a maximum RF output power of 0 dBm e.i.r.p.

5.2.2 Receiver Spurious Emissions

5.2.2.1 Limit

Receiver spurious emissions are emissions at any frequency when the equipment is in receive mode.

The spurious emissions of the transmitter shall not exceed the values in following tables for the EUT in this report.

Frequency range	Maximum power (dBm)	Bandwidth
30 MHz to 1 GHz	-57	100 KHz
1 GHz to 12.75 GHz	-47	1 MHz

5.2.2.2 Test Setup

The section 4.5.1 (Diagram 1) for test setup description. The photo of test setup please refer to ANNEX B.

5.2.2.3 Test Procedure

Reference to ETSI EN 300 328 V2.1.1 clause 5.4.10.2.

5.2.2.4 Test Result

Please refer to ANNEX A.11.

5.2.3 Receiver Blocking

5.2.3.1 Limit

While maintaining the minimum performance criteria as defined in clause 4.3.1.12.3, the blocking levels at specified frequency offsets shall be equal to or greater than the limits defined for the applicable receiver category provided in next table.

Receiver Category 1 equipment

Wanted signal mean power from companion device (dBm)	Blocking signal frequency(MHz)	Blocking signal power (dBm) (see note 2)	Type of blocking signal
Pmin + 6 dB	2 380	-53	CW
	2 503.5	-53	CW
Pmin + 6 dB	2 300	-47	CW
	2 330	-47	CW
	2 360	-47	CW
Pmin + 6 dB	2 523.5	-47	CW
	2 553.5	-47	CW
	2 583.5	-47	CW
	2 613.5	-47	CW
	2 643.5	-47	CW
	2 673.5	-47	CW

Note ¹: Pmin is the minimum level of wanted signal (in dBm) required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.

Note ²: The levels specified are levels in front of the UUT antenna. In case of conducted measurements, the levels have to be corrected by the actual antenna assembly gain.

Receiver Category 2 equipment

Wanted signal mean power from companion device (dBm)	Blocking signal frequency(MHz)	Blocking signal power (dBm) (see note 2)	Type of blocking signal
Pmin + 6 dB	2 380	-57	CW
	2 503.5	-57	CW
Pmin + 6 dB	2 300	-47	CW
	2 583.5	-47	CW

Note ¹: Pmin is the minimum level of the wanted signal (in dBm) required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.

Note ²: The levels specified are levels in front of the UUT antenna. In case of conducted measurements, the levels have to be corrected by the actual antenna assembly gain.

Receiver Category 3 equipment

Wanted signal mean power from companion device (dBm)	Blocking signal frequency(MHz)	Blocking signal power (dBm) (see note 2)	Type of blocking signal
Pmin + 12 dB	2 380	-57	CW
	2 503.5	-57	CW
Pmin + 12 dB	2 300	-47	CW
	2 583.5	-47	CW

Note ¹: Pmin is the minimum level of the wanted signal (in dBm) required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.

Note ²: The levels specified are levels in front of the UUT antenna. In case of conducted measurements, the levels have to be corrected by the actual antenna assembly gain.

Categorization

Receiver category	Definition
1	Adaptive equipment with a maximum RF output power greater than 10 dBm e.i.r.p. shall be considered as receiver category 1 equipment.
2	Non-adaptive equipment with a Medium Utilization (MU) factor greater than 1 % and less than or equal to 10 % or adaptive equipment with a maximum RF output power of 10 dBm e.i.r.p. shall be considered as receiver category 2 equipment.
3	Non-adaptive equipment with a maximum Medium Utilization (MU) factor of 1 % or adaptive equipment with a maximum RF output power of 0 dBm e.i.r.p. shall be considered as receiver category 3 equipment

5.2.3.2 Test Setup

See the section 4.5.3 (Diagram 4) for test setup description. The photo of test setup please refer to ANNEX B.

5.2.3.3 Test Procedure

Reference to ETSI EN 300 328 V2.1.1 clause 5.4.11.2.

5.2.3.4 Test Result

Please refer to ANNEX A.12.

5.3 Other Parameters

5.3.1 Geo-location capability

5.3.1.1 Requirements

The geographical location determined by the equipment as defined in following section (5.3.1.2) shall not be accessible to the user.

5.3.1.2 Definition

Geo-location capability is a feature of the equipment to determine its geographical location with the purpose to configure itself according to the regulatory requirements applicable at the geographical location where it operates.

The geo-location capability may be present in the equipment or in an external device (temporary) associated with the equipment operating at the same geographical location during the initial power up of the equipment. The geographical location may also be available in equipment already installed and operating at the same geographical location.

5.3.1.3 Test Result

Please refer to section 3.

ANNEX A TEST RESULT

A.1 RF output power

Test Data

Note: EIRP Power = Conducted Power + Antenna Gain

Modulation Mode		GFSK(BLE)			
Limit		20 dBm			
Test Result					
Test Method	Test Conditions		Transmitter Power Level (dBm)		
<input type="checkbox"/> Radiated <input checked="" type="checkbox"/> Conducted	Voltage NV	Temperature NT LT HT	Low Channel EIRP	Middle Channel EIRP	High Channel EIRP
			5.0	5.5	6.5
			4.8	5.5	6.4
Test Verdict			Pass		

Bursts Power List

GFSK (BLE): Low Channel

Burst RMS Power	Start Time	Stop Time	Tx_on	Tx_off
dBm	ms	ms	ms	ms
5.1	0.000	1.704	1.704	0.796
5.1	2.500	4.205	1.705	0.795
5.1	5.000	6.704	1.704	0.796
5.1	7.500	9.204	1.704	0.796
5.1	10.000	11.704	1.704	0.795
5.1	12.499	14.204	1.705	0.796
5.1	15.000	16.704	1.704	0.796
5.1	17.500	19.204	1.704	0.795
5.1	19.999	21.704	1.705	0.795
5.1	22.499	24.204	1.705	0.795
5.1	24.999	26.704	1.705	0.796
5.1	27.500	29.204	1.704	0.795
5.1	29.999	31.704	1.705	0.795
5.1	32.499	34.204	1.705	0.795
5.1	34.999	36.704	1.705	0.795
5.1	37.499	39.203	1.704	0.796
5.1	39.999	41.704	1.705	0.795
5.1	42.499	44.204	1.705	0.795
5.1	44.999	46.704	1.705	0.795
5.1	47.499	49.203	1.704	0.796
5.1	49.999	51.703	1.704	0.796
5.1	52.499	54.204	1.705	0.795
5.1	54.999	56.703	1.704	0.796
5.1	57.499	59.203	1.704	0.796
5.1	59.999	61.703	1.704	0.796
5.1	62.499	64.203	1.704	0.796
5.1	64.999	66.703	1.704	0.796
5.1	67.499	69.203	1.704	0.796
5.1	69.999	71.703	1.704	0.795
5.1	72.498	74.203	1.705	0.795
5.1	74.998	76.703	1.705	0.796
5.1	77.499	79.203	1.704	0.795
5.1	79.998	81.703	1.705	0.795
5.1	82.498	84.203	1.705	0.795

GFSK (BLE): Middle Channel

Burst RMS Power	Start Time	Stop Time	Tx_on	Tx_off
dBm	ms	ms	ms	ms
5.5	0.000	1.705	1.705	0.795
5.5	2.500	4.205	1.705	0.795
5.5	5.000	6.704	1.704	0.796
5.5	7.500	9.204	1.704	0.796
5.5	10.000	11.704	1.704	0.796
5.5	12.500	14.205	1.705	0.795
5.5	15.000	16.704	1.704	0.796
5.5	17.500	19.204	1.704	0.796
5.5	20.000	21.704	1.704	0.796
5.5	22.500	24.204	1.704	0.796
5.5	25.000	26.704	1.704	0.796
5.5	27.500	29.204	1.704	0.796
5.5	30.000	31.704	1.704	0.795
5.5	32.499	34.204	1.705	0.795
5.5	34.999	36.704	1.705	0.796
5.5	37.500	39.204	1.704	0.795
5.5	39.999	41.704	1.705	0.795
5.5	42.499	44.204	1.705	0.795
5.5	44.999	46.704	1.705	0.795
5.5	47.499	49.204	1.705	0.795
5.5	49.999	51.704	1.705	0.795
5.5	52.499	54.204	1.705	0.795
5.5	54.999	56.704	1.705	0.795
5.5	57.499	59.203	1.704	0.796
5.5	59.999	61.704	1.705	0.795
5.5	62.499	64.204	1.705	0.795
5.5	64.999	66.704	1.705	0.795
5.5	67.499	69.203	1.704	0.796
5.5	69.999	71.703	1.704	0.796
5.5	72.499	74.204	1.705	0.795
5.5	74.999	76.703	1.704	0.796
5.5	77.499	79.203	1.704	0.796
5.5	79.999	81.703	1.704	0.796
5.5	82.499	84.203	1.704	0.796

GFSK (BLE): High Channel

Burst RMS Power	Start Time	Stop Time	Tx_on	Tx_off
dBm	ms	ms	ms	ms
6.5	0.000	1.704	1.704	0.796
6.4	2.500	4.205	1.705	0.795
6.4	5.000	6.704	1.704	0.796
6.4	7.500	9.204	1.704	0.796
6.5	10.000	11.704	1.704	0.796
6.4	12.500	14.204	1.704	0.796
6.4	15.000	16.704	1.704	0.796
6.4	17.500	19.204	1.704	0.796
6.4	20.000	21.704	1.704	0.795
6.4	22.499	24.204	1.705	0.795
6.4	24.999	26.704	1.705	0.796
6.4	27.500	29.204	1.704	0.796
6.4	30.000	31.704	1.704	0.795
6.4	32.499	34.204	1.705	0.795
6.4	34.999	36.704	1.705	0.795
6.5	37.499	39.204	1.705	0.795
6.4	39.999	41.704	1.705	0.795
6.4	42.499	44.204	1.705	0.795
6.4	44.999	46.704	1.705	0.795
6.4	47.499	49.203	1.704	0.796
6.4	49.999	51.703	1.704	0.796
6.4	52.499	54.204	1.705	0.795
6.4	54.999	56.704	1.705	0.795
6.5	57.499	59.203	1.704	0.796
6.5	59.999	61.703	1.704	0.796
6.5	62.499	64.203	1.704	0.796
6.5	64.999	66.703	1.704	0.796
6.4	67.499	69.203	1.704	0.796
6.4	69.999	71.703	1.704	0.796
6.4	72.499	74.203	1.704	0.795
6.4	74.998	76.703	1.705	0.796
6.4	77.499	79.203	1.704	0.796
6.4	79.999	81.703	1.704	0.795
6.4	82.498	84.203	1.705	0.795

A.2 Power spectral density

Measuring Parameter

Frequency Range	RBW (MHz)	10 kHz
2400 MHz to 2483.5 MHz	VBW (MHz)	30 kHz
	Sweep points	8351
	Detector mode	RMS
	Trace mode	Max Hold
	Sweep time	Auto

Test Data

Note: The Power density is ERIP Power density, which is contain antenna gain.

Modulation Mode		GFSK (BLE)				
Limit		10 dBm/MHz				
Test Result						
Test Method		Test Conditions		Power density (dBm/MHz)		
<input type="checkbox"/> Radiated	Temperature	Voltage	Low Channel	Middle Channel		
			Power Spectral density	Power Spectral density		
			NT	NV	4.9	5.5
Test Verdict			Pass			

A.3 Duty Cycle, Tx-sequence, Tx-gap

Note ¹: The maximum value of Duty Cycle declared by the supplier.

Test Data

Duty Cycle (%)	Limit Duty Cycle (%) ^{Note1}	Number of Bursts	Minimum Tx-On (ms)	Maximum Tx-On (ms)	Minimum Tx-Off (ms)	Maximum Tx-Off (ms)	Measurement Time (ms)	Comment
--	--	--	--	--	--	--	--	--

Note ²: Not applicable.

A.4 Accumulated Transmit Time, Frequency Occupation and Hopping Sequence

Note: Not applicable.

A.5 Hopping Frequency Separation

Note: Not applicable.

A.6 Medium Utilisation (MU) factor

Medium Utilisation (MU) (%)	Limit Medium Utilisation (MU) (%)	Verdict
--	10	--

Note: Not applicable.

A.7 Adaptivity

Note: Not applicable.

A.8 Occupied Channel Bandwidth

Measuring Parameter

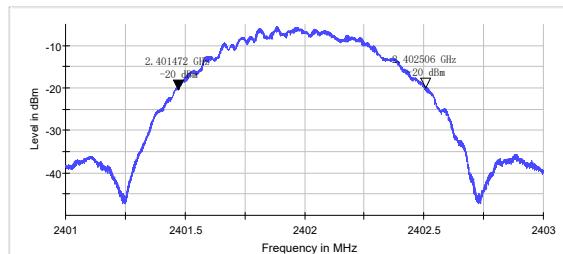
Centre Frequency	The centre frequency of the channel under test
RBW (kHz)	100 kHz
VBW (kHz)	300 kHz
Span (MHz)	3 MHz
Detector mode	RMS
Trace mode	Max Hold
Sweep time	Auto
Test Method	<input type="checkbox"/> Radiated <input checked="" type="checkbox"/> Conducted

Test Data

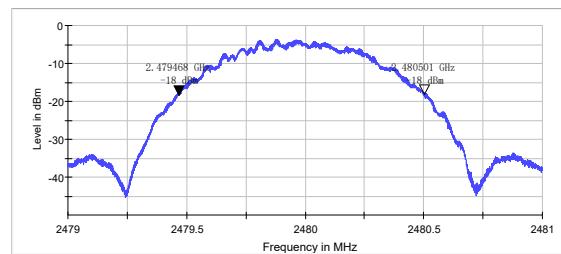
Test Conditions		Test Mode	DUT Frequency (MHz)	Channel Centre Frequency (MHz)	Occupied Channel Bandwidth (MHz)	Lower Band Edge (MHz)	Upper Band Edge (MHz)	Limit (MHz)
Tempe rature	Voltage							
NT	NV	GFSK (BLE)	2402	2401.988627	1.034121	2401.471566	2402.505687	Within The Band 2400 MHz to 2483.5 MHz
			2480	2479.984502	1.033371	2479.467817	2480.501188	
Test Verdict		Pass						

Test Plots

GFSK (BLE):: Low Channel



GFSK (BLE):: High Channel



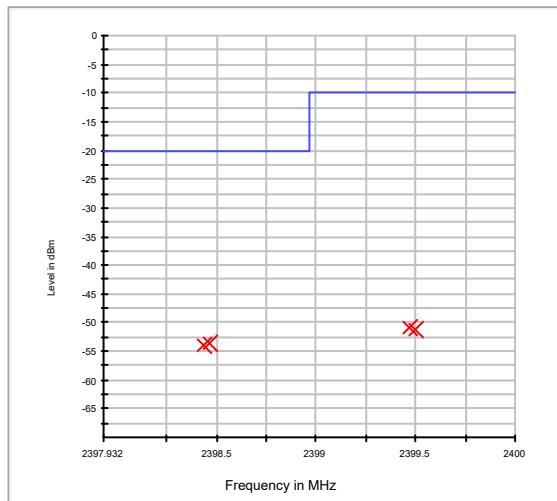
A.9 Transmitter unwanted emissions in the out-of-band domain

Test Data

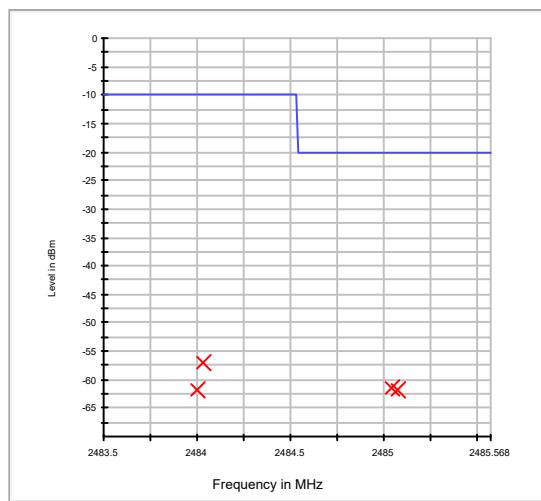
Test Method	Test Conditions		Test Mode	Frequency (MHz)	OOB Emission Worst level(dBm/MHz)	Limit(dBm/MHz)
	Temperature	Voltage				
<input type="checkbox"/> Radiated	NV	NT	GFSK (BLE)	2402	-51.0	-10,-20
<input checked="" type="checkbox"/> Conducted				2480	-52.8	-10,-20
Test Verdict			Pass			

Test Plots

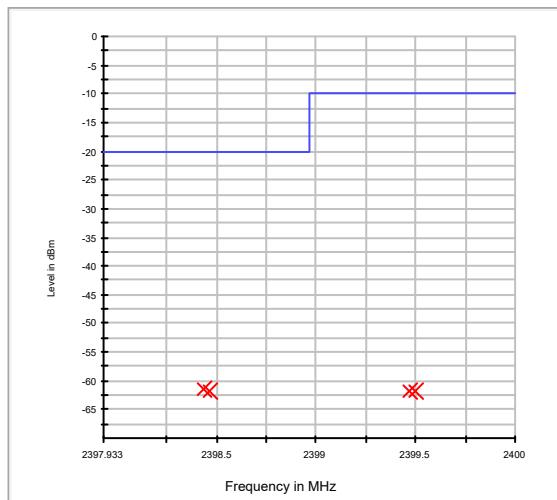
GFSK (BLE): Low frequency (Part 1)



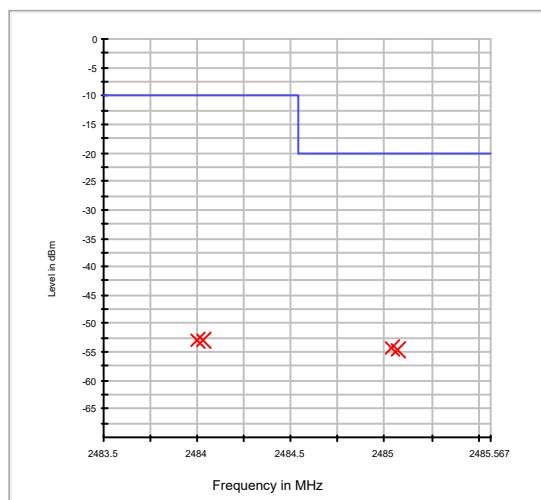
GFSK (BLE): Low frequency (Part 2)



GFSK (BLE): High frequency (Part 1)



GFSK (BLE): High frequency (Part 2)



A.10 Transmitter Spurious Emissions

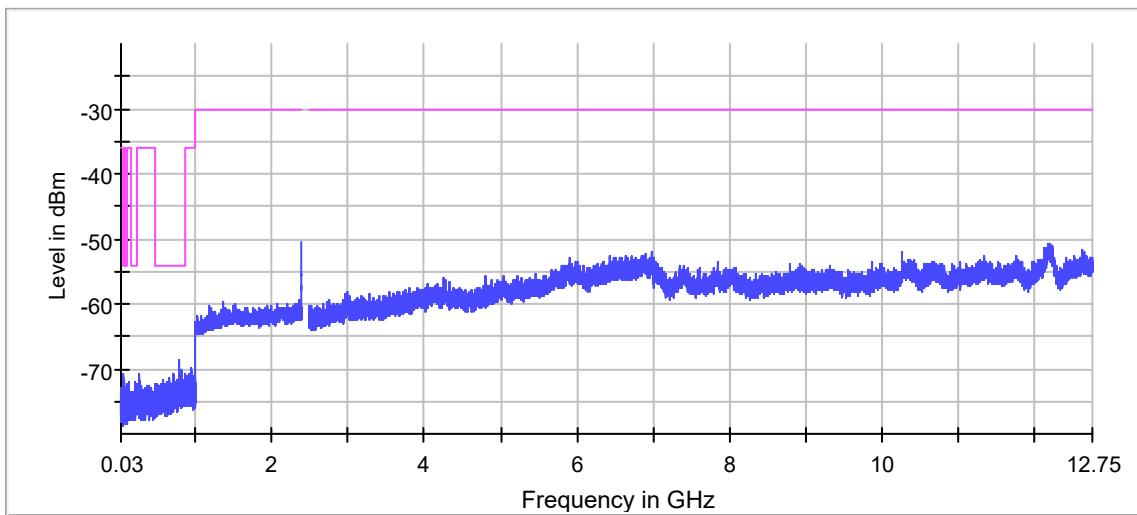
Note: The Frequency band was pre-scanned, the harmonic and other spurious which worst frequency are recorded in the report.

Measuring Parameter

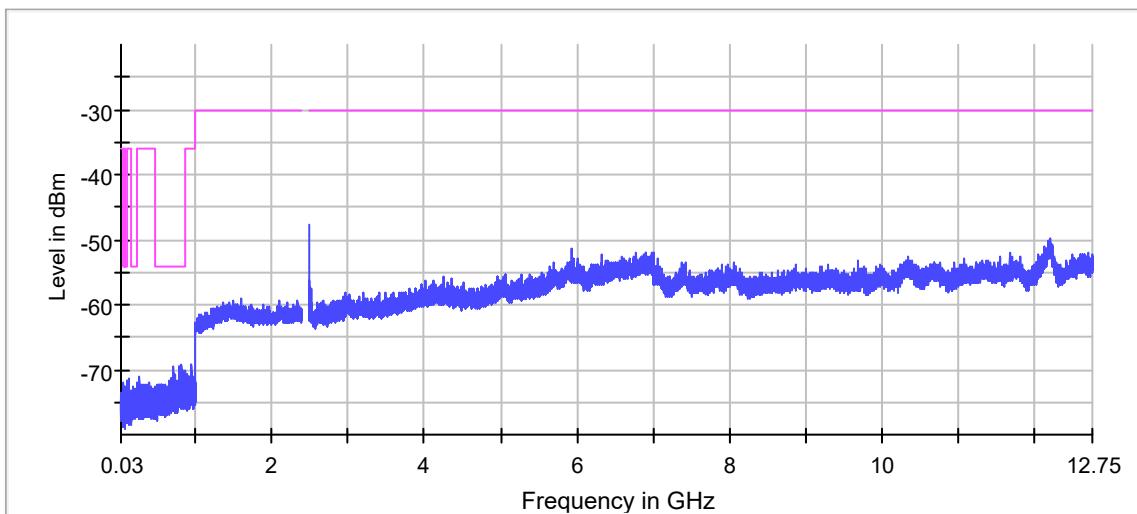
Frequency Range		
30 MHz to 1 000 MHz	RBW (MHz)	100 kHz
	VBW (MHz)	300 kHz
	Sweep points	19400
	Detector mode	Peak
	Trace mode	Max Hold
1 GHz to 12,75 GHz	RBW (MHz)	1 MHz
	VBW (MHz)	3 MHz
	Sweep points	23500
	Detector mode	Peak
	Trace mode	Max Hold

Conducted Test Data

GFSK (BLE) Low Frequency



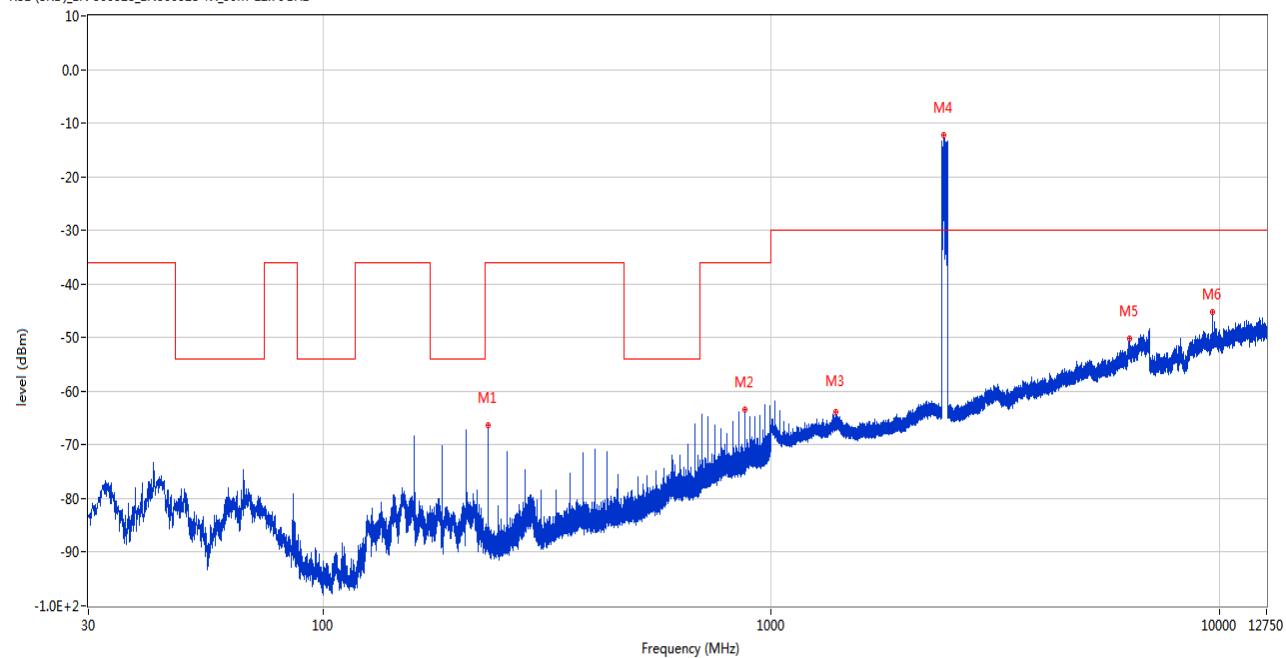
GFSK (BLE) High Frequency



Cabinet Radiated Test Data

30 MHz to 12.75 GHz, ANT V

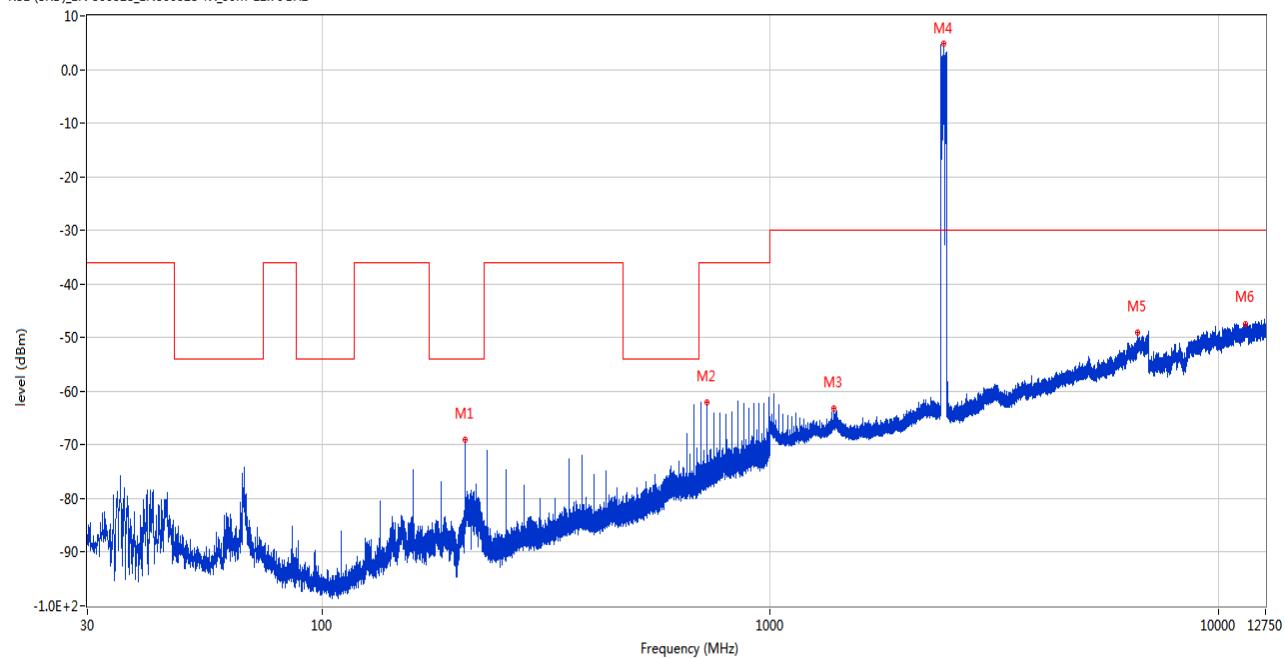
RSE (SRD)_EN 300328_EN300328 TX_30M-12.75GHz



Frequency (MHz)	Result (dBm)	Factor (dB)	PK Limit (dBm)	Over Limit (dB)	Table (o)	ANT	EUT	Verdict
233.506	-66.27	-15.33	-36.0	-30.27	83.00	Vertical	Horizontal	Pass
872.494	-63.45	1.89	-36.0	-27.45	182.00	Vertical	Horizontal	Pass
1393.400	-63.83	-4.37	-30.0	-33.83	305.00	Vertical	Horizontal	Pass
2427.100	-12.32	-2.08	-30.0	17.68	7.00	Vertical	Horizontal	N/A
6299.400	-50.19	10.89	-30.0	-20.19	103.00	Vertical	Horizontal	Pass
9648.451	-45.31	16.36	-30.0	-15.31	141.00	Vertical	Horizontal	Pass

30 MHz to 12.75 GHz, ANT H

RSE (SRD)_EN 300328_EN300328 TX_30M-12.75GHz



Frequency (MHz)	Result (dBm)	Factor (dB)	PK Limit (dBm)	Over Limit (dB)	Table (o)	ANT	EUT	Verdict
208.916	-68.99	-15.94	-54.0	-14.99	115.00	Horizontal	Horizontal	Pass
725.054	-62.16	-1.03	-36.0	-26.16	330.00	Horizontal	Horizontal	Pass
1388.500	-63.27	-4.49	-30.0	-33.27	267.00	Horizontal	Horizontal	Pass
2439.000	4.82	-2.12	-30.0	34.82	360.00	Horizontal	Horizontal	N/A
6608.600	-49.10	12.25	-30.0	-19.10	63.00	Horizontal	Horizontal	Pass
11486.725	-47.47	17.72	-30.0	-17.47	269.00	Horizontal	Horizontal	Pass

A.11 Receiver Spurious Emissions

Note ¹: The test method choose the conducted method. Which power in a specified load (conducted spurious emissions) and their effective radiated power when radiated by the cabinet or structure of the equipment (cabinet radiation).

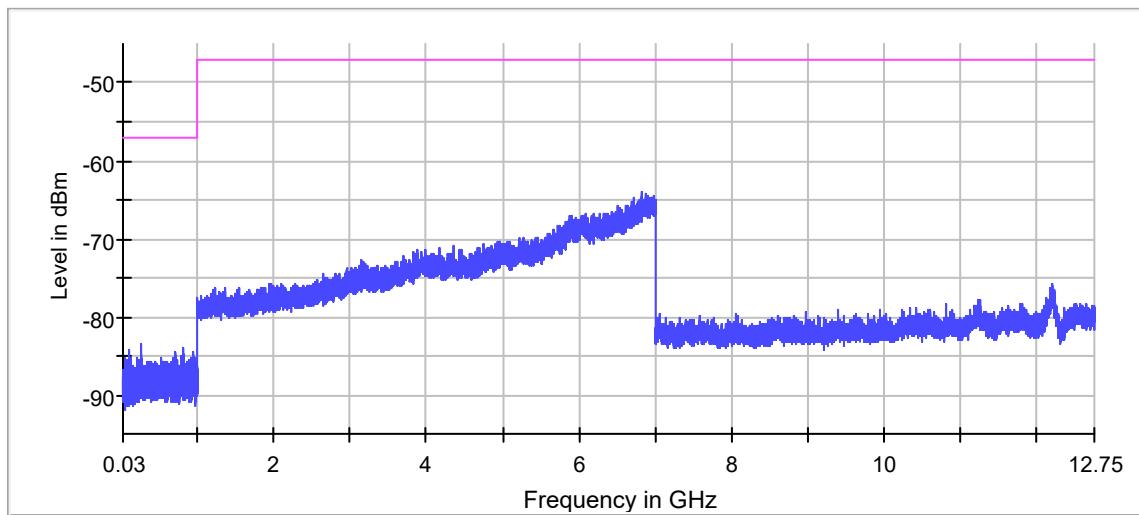
Note ²: The Frequency band was pre-scanned, the harmonic and other spurious which worst frequency are recorded in the report.

Measuring Parameter

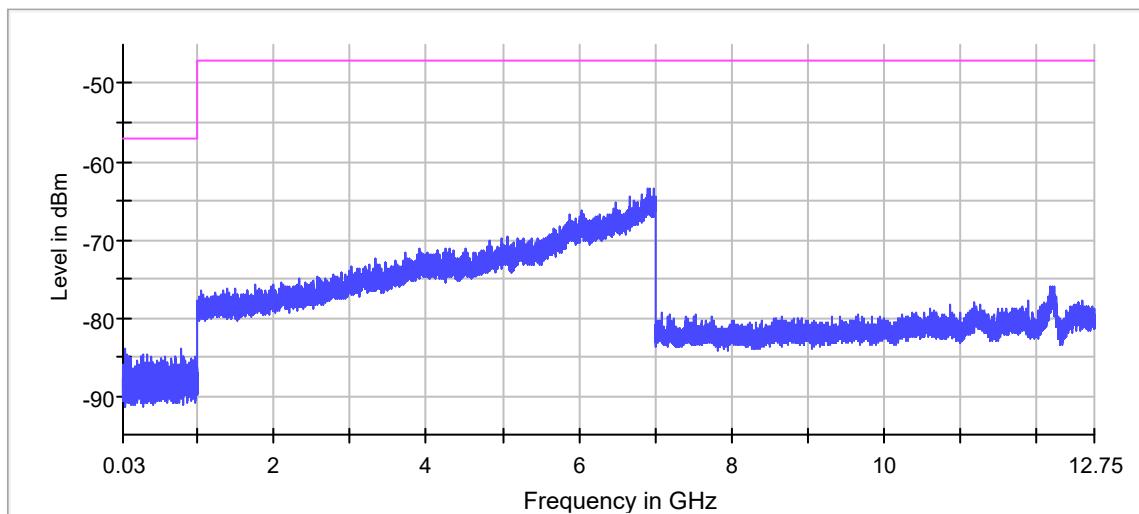
Frequency Range	RBW (MHz)	100 kHz
30 MHz to 1 000 MHz	VBW (MHz)	300 kHz
	Sweep points	19400
	Detector mode	Peak
	Trace mode	Max Hold
	RBW (MHz)	1 MHz
1 GHz to 12,75 GHz	VBW (MHz)	3 MHz
	Sweep points	23500
	Detector mode	Peak
	Trace mode	Max Hold

Conducted Test Data

GFSK (BLE) Low Frequency

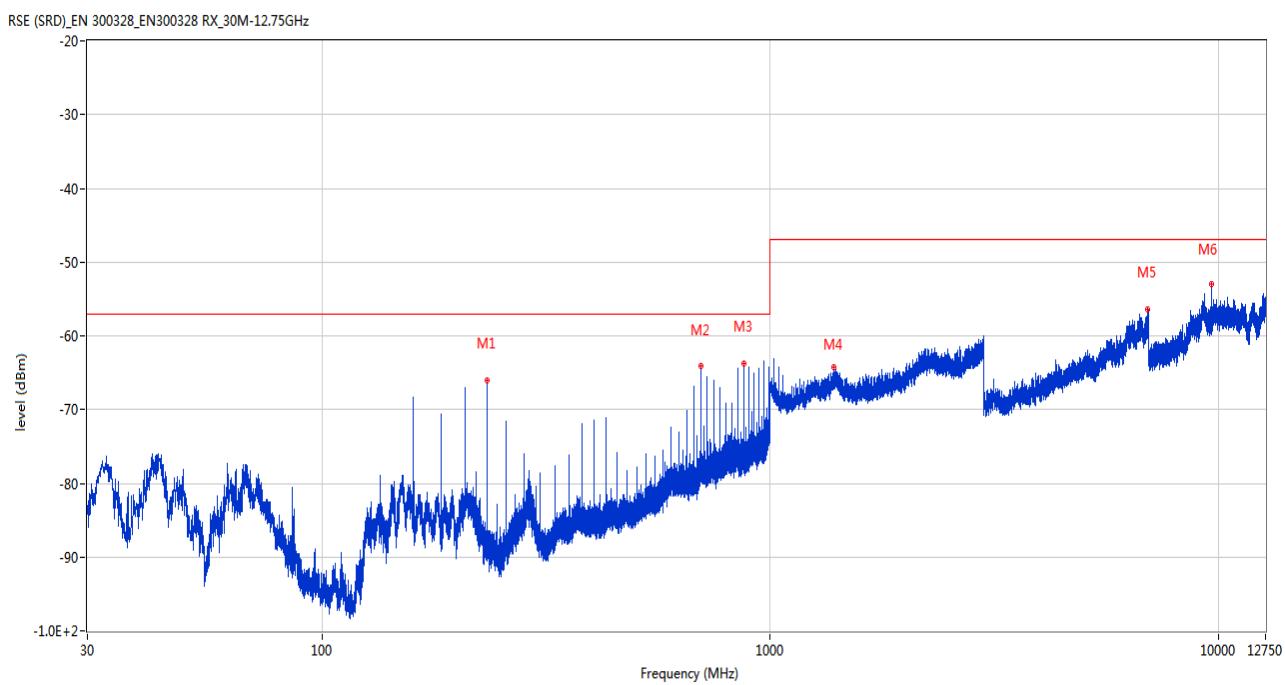


GFSK (BLE) High Frequency



Cabinet Radiated Test Data

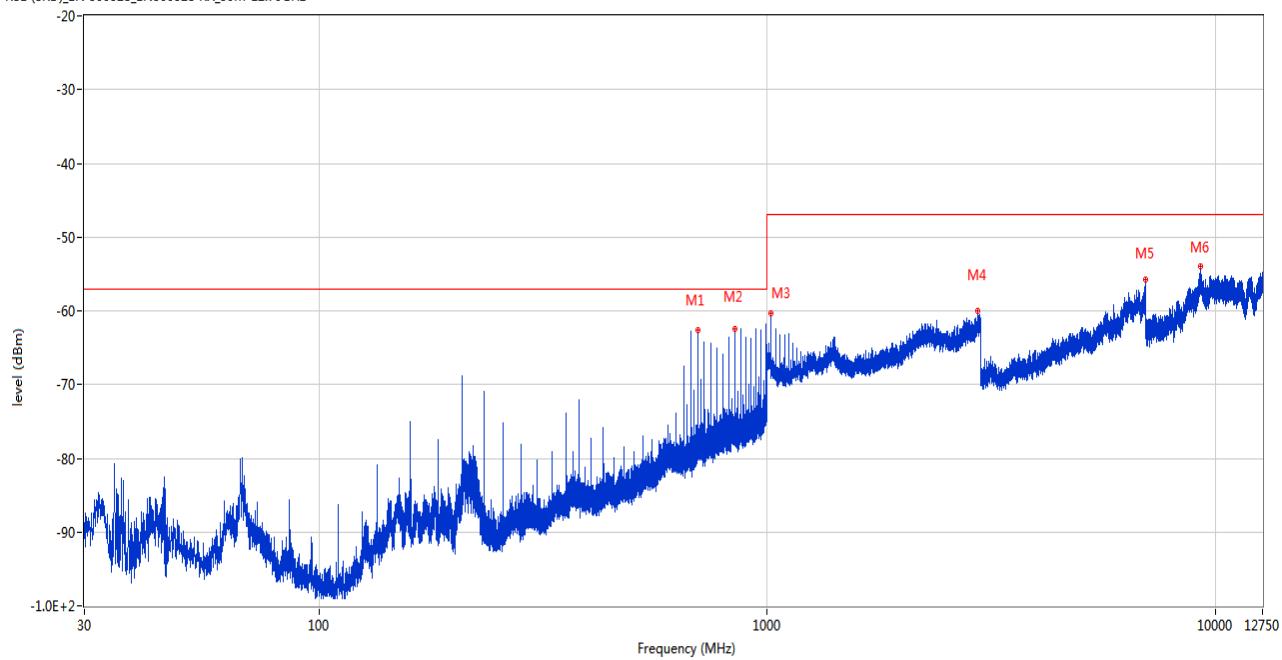
30 MHz to 12.75 GHz, ANT V



Frequency (MHz)	Result (dBm)	Factor (dB)	PK Limit (dBm)	Over Limit (dB)	Table (o)	ANT	EUT	Verdict
233.506	-66.08	-15.33	-57.0	-9.08	68.00	Vertical	Horizontal	Pass
700.464	-64.06	-1.92	-57.0	-7.06	226.00	Vertical	Horizontal	Pass
872.494	-63.70	1.89	-57.0	-6.70	182.00	Vertical	Horizontal	Pass
1390.200	-64.32	-4.46	-47.0	-17.32	113.00	Vertical	Horizontal	Pass
6968.600	-56.40	5.77	-47.0	-9.40	360.00	Vertical	Horizontal	Pass
9648.162	-52.96	8.32	-47.0	-5.96	141.00	Vertical	Horizontal	Pass

30 MHz to 12.75 GHz, ANT H

RSE (SRD)_EN 300328_EN300328 RX_30M-12.75GHz



Frequency (MHz)	Result (dBm)	Factor (dB)	PK Limit (dBm)	Over Limit (dB)	Table (o)	ANT	EUT	Verdict
700.464	-62.61	-1.92	-57.0	-5.61	322.00	Horizontal	Horizontal	Pass
847.904	-62.45	1.32	-57.0	-5.45	352.00	Horizontal	Horizontal	Pass
1020.100	-60.38	-4.98	-47.0	-13.38	67.00	Horizontal	Horizontal	Pass
2950.800	-59.95	1.07	-47.0	-12.95	60.00	Horizontal	Horizontal	Pass
7000.000	-55.80	5.92	-47.0	-8.80	44.00	Horizontal	Horizontal	Pass
9261.475	-53.99	9.28	-47.0	-6.99	164.00	Horizontal	Horizontal	Pass

A.12 Receiver Blocking

Note: Equipment does not support a PER or a FER test to be performed. After adding interference, the device will not lose the wireless transmission function required for the intended use of the device, tests pass.

Receiver Category 2 equipment

Wanted signal mean power from companion device (dBm) (see notes 1 and 3)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 3)	Limit	Verdict
(-139 dBm + 10 × log ₁₀ (OCBW) + 10 dB) or (-74 dBm + 10 dB) whichever is less	2 380	-34	normal work	Pass
	2 504	-34		
	2 300	-34		
	2 584	-34		

ANNEX B TEST SETUP PHOTOS

Please refer the document "BL-SZ2140980-AR.pdf".

ANNEX C EUT EXTERNAL PHOTOS

Please refer the document "BL-SZ2140980-AW.pdf".

ANNEX D EUT INTERNAL PHOTOS

Please refer the document "BL-SZ2140980-AI.pdf".

--END OF REPORT--